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The STRS (shortness of breath, tremulousness, racing heart, and sweating): A brief checklist for acute distress with panic-like autonomic indicators; development and factor structure

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Abstract

Background: Peritraumatic response, as currently assessed by Posttraumatic Stress Disorder (PTSD) diagnostic criterion A2, has weak positive predictive value (PPV) with respect to PTSD diagnosis. Research suggests that indicators of peritraumatic autonomic activation may supplement the PPV of PTSD criterion A2. We describe the development and factor structure of the STRS (Shortness of Breath, Tremulousness, Racing Heart, and Sweating), a one page, two-minute checklist with a five-point Likert-type response format based on a previously unpublished scale. It is the first validated self-report measure of peritraumatic activation of the autonomic nervous system.

Methods: We selected items from the Potential Stressful Events Interview (PSEI) to represent two latent variables: 1) PTSD diagnostic criterion A, and 2) acute autonomic activation. Participants (a convenience sample of 162 non-treatment seeking young adults) rated the most distressing incident of their lives on these items. We examined the factor structure of the STRS in this sample using factor and cluster analysis.

Results: Results confirmed a two-factor model. The factors together accounted for 68% of the variance. The variance in each item accounted for by the two factors together ranged from 41% to 74%. The item loadings on the two factors mapped precisely onto the two proposed latent variables.

Conclusion: The factor structure of the STRS is robust and interpretable. Autonomic activation signs tapped by the STRS constitute a dimension of the acute autonomic activation in response to stress that is distinct from the current PTSD criterion A2. Since the PTSD diagnostic criteria are likely to change in the DSM-V, further research is warranted to determine whether signs of peritraumatic autonomic activation such as those measured by this two-minute scale add to the positive predictive power of the current PTSD criterion A2. Additionally, future research is warranted to explore whether the four automatic activation items of the STRS can be useful as the basis for a possible PTSD criterion A3 in the DSM-V.

Background

This paper describes the development and validation of a very brief measure of peritraumatic autonomic activation, the STRS (Shortness of Breath, Tremulousness, Racing Heart, and Sweating) checklist. The development of this measure was motivated, in part, by the poor psychometric properties of previous self-report measures [1]. This limitation is especially characteristic of measures utilizing the current diagnostic criteria for Posttraumatic Stress Disorder (PTSD). The PTSD diagnostic criteria in the Diagnostic and Statistical Manual of Mental Disorders, fourth edition, Text Revision (DSM-IV-TR) [2] are as follows: Exposure to a traumatic or life-threatening incident (criterion A1); experience of intense fear, helplessness, or horror in response to the incident (criterion A2); and symptoms from each of three incident-related categories (re-experiencing, avoidance, and hyperarousal; criteria B-D).

Several shortcomings of criteria A1 and A2 have come under increasing scrutiny [3-9]. One identified shortcoming of criterion A2 is that it may be too broad, and its positive predictive value (PPV) for a diagnosis of PTSD is poor. For example, Schnurr et al., in reanalyzing data from a study by Brewin et al. [10], calculated that criterion A2 has a PPV of only 0.34 for PTSD among victims of violent crime [11].

An important reason for the low PPV of criterion A2 may be that it fails to include a significant dimension of the human hardwired acute response to threat. Recent reviews of the acute responses to extreme stress highlight the importance of peritraumatic "panic-like" autonomic activation [4-8,12-22]. Although the signs of the acute autonomic activation in response to stress have been well known for 75 years [19,23], surprisingly little research has examined the diagnostic and prognostic value of any sign except for tachycardia. The lack of a validated measure that utilizes multiple discrete indicators of acute autonomic activation may be an important factor impeding such research. This was one of the principle motivations for the development of the measure we present here, the STRS (Shortness of Breath, Tremulousness, Racing Heart, and Sweating) checklist.

Important recent PTSD research by Shalev, Pitman, Bryant, Vaiva, Raskind, and other groups have shown the utility of identifying and treating one major sign of excessive autonomic activation (tachycardia) in the immediate aftermath of a fear-inducing incident [3,6,15,24], though one study has reported a contrary finding [25]. There is no reason to assume that peritraumatic tachycardia is unique among autonomic hyperarousal signs in predicting PTSD. Therefore, current research on peritraumatic predictors of PTSD is focused both on tachycardia [3-7,15,16,22,24] as

well as on other acute "panic" or "fright" symptoms [8,19,20,26,27].

In the aftermath of a major man-made or natural disaster, to which large numbers of individuals have been exposed, it may not always be possible to immediately record heart rate (or other autonomic activation signs) in an emergency-room setting as was done in some of the above landmark studies. More importantly, exclusive reliance on tachycardia runs the risk of missing autonomic signs in individuals whose tachycardia is less pronounced due to a high level of physical fitness (e.g., military personnel, police officers, and firefighters), less noticeable, or less memorable than other more fear-specific signs (e.g., sweaty palms and tremulousness).

Additionally, the stigma attached to emotional and cognitive stress responses following traumatic incidents may be partly to blame for the low PPV of criterion A2. Stigma is known to impact the validity of measurements of acute stress response across cultures and ethnic groups [28,29]. Stigma is an especially strong source of bias (and a self-imposed obstacle to treatment) among Japanese- and Chinese-Americans, Pacific Islanders, military personnel, police officers, firefighters, and among males in general (for a comprehensive review, see Marsella et al. [28]). Non-volitional hardwired autonomic responses, such as sweaty palms and tremulousness may be less stigmatizing and hence less biased indicators of acute stress response.

The STRS is based on a previously unpublished scale (Kilpatrick, Resnick, & Freedy [1991], unpublished), the Potential Stressful Events Interview (PSEI). The PSEI is a 35-page, comprehensive structured interview developed for and used in the DSM-IV PTSD field trials [30]. It covers a broad array of both high-magnitude and low-magnitude stressors and 25 peritraumatic responses to each stressor (the Subjective Responses Scales). While the PSEI has high face validity, no psychometric evaluations of the Subjective Responses Scales currently exist. All items in the STRS are taken from the Subjective Responses Scales. In this manuscript we describe the development and our examination of the factor structure of the STRS.

Method

Sample

The Department of Veterans Affairs Human Subjects Committee approved the research protocol as part of a larger study of potential biomarkers of premorbid extreme autonomic activation episodes as histologically manifested in dental tissue [20,21]. A total of 307 English-speaking young adults were chosen from a non-psychiatric treatment setting. They were recruited from eight mostly private dental clinics in the Honolulu area after undergoing an elective 3rd molar extraction indicated for

Table 1: The 14 original items

Item	Endorsement rate*	Retained in STRS
1 ...fearful or scared	96.3%	Yes (A2)
2 ...you or other injured or killed	100.0%†	Yes (A1)
3 ...helpless	95.1%	Yes (A2)
4 ...shortness of breath	66.0%	Yes (S)
5 ...dizziness or feeling faint	48.8%	
6 ...heart pounding or racing	92.6%	Yes (R)
7 ...trembling, shaking, buckling knees	65.4%	Yes (T)
8 ...sweaty palms or other sweating	63.6%	Yes (S)
9 ...stomach distress or nausea	53.1%	
10 ...numbness or tingling	37.6%	
11 ...hot flashes or chills	21.0%	
12 ...choking or dry mouth	29.4%	
13 ...chest pain or discomfort	29.4%	
14 ...difficulty controlling bladder or bowels	3.1%	

* 1.0 minus the percentage of respondents answering 0 ("Not at all") † Inclusion criterion (PTSD criterion A1)

dental reasons. Each participant provided written informed consent permitting us to conduct a comprehensive stressor-history interview, obtain their complete pediatric records, and examine their dental tissue for potential biomarkers of repeated extreme autonomic activation. Participants were paid \$100 for their time and travel expenses.

Data collection

For each participant, all stressor-history data were collected during a 1.5 hour structured interview (using a culturally modified version of the PSEI) conducted by a psychologist and a masters-level clinician. Participants initially completed a calendar of major life incidents and transitional events to increase the reliability of their stressful incident recall [31]. They then were asked to recall all stressful life incidents that occurred prior to age 21. Finally, for each stressful incident reported, participants rated their experience of the incident on 14 items intended to capture the A1 and A2 DSM-IV-TR PTSD criteria and a collection of common autonomic activation indicators.

Scale development

We began with the original 25 items from the two components of the Subjective Responses Scales of the PSEI: the HM-F-1A (Degree of Emotional Response form) and the HM-F-1B (Degree of Physical Reaction form). First, we eliminated items that did not capture one of two theoretically predetermined categories: 1) A1 and A2 diagnostic criteria for PTSD; 2) signs of acute autonomic activation (elevated sympathovagal ratio). This resulted in 13 items: one for criterion A1, two for matching subjective components of criterion A2, and all ten items from the Degree of Physical Reaction form. "Horror" was not an item in the

Degree of Emotional Response form (Kilpatrick, Resnick, Freedy [1991], unpublished) and was also not included in the item list we culled from it.

Next, we consulted with PTSD experts and with experts on autonomic system activation to ensure all relevant signs of acute autonomic activation were considered (consultants are listed in the acknowledgment section below). Based on these consultations, we reviewed item wording and modified items we thought would be improved by greater specificity. We also added one item characteristic of extreme parasympathetic nervous system activation: loss of bladder or bowel control. This item was adapted from Brunet's 13-item Peritraumatic Distress Inventory [27].

This process resulted in the retention of the 14 items listed in Table 1. We then administered these items to our sample. Next, we discarded items that were endorsed by fewer than 60 percent of participants. Finally, we performed a factor analysis and a cluster analysis on the resulting data.

Scale and item format

The STRS format validated in this study was an interview (Figure 1). It can also be self-administered. Using the same response format as the PSEI, respondents rate the extent to which they experienced the phenomena described by each item on a five-point Likert-type scale ranging from 0 ("Not at all") to 4 ("An extreme amount").

Data reduction and analysis

The 307 participants reported 1,557 incidents. To decrease error due to time passed since the incident and age at the time of the incident, ratings were excluded from analysis if the incident occurred more than 14 years prior to the interview or if the participant was younger than 7

STRS: A distress checklist with panic-like autonomic response indicators; designed to facilitate the augmentation of the positive predictive value of PTSD criterion A2 in acute stress response research and disaster-aftermath screening. Bracha, Williams, Haynes, Kubany et al., 2004		<h1 style="text-align: center;">STRS</h1> <p style="text-align: center;">(Shortness, Trembling, Racing, Sweating) A Symptom Checklist for Acute Distress Interview version (2 minutes)</p>				
Interviewer: Read aloud only shaded and capitalized texts. Complete one page for each incident.						
YOU HAVE SAID _____ HAS HAPPENED TO YOU # _____ TIMES. I WANT TO ASK YOU SOME QUESTIONS ABOUT YOUR REACTIONS TO THE (Circle) 1st 2nd 3rd 4th _____ TIME.						
Interviewer: Record age at the time of circled incident here _____ years						
PLEASE INDICATE WHETHER YOU HAD ANY OF THESE FEELINGS OR THOUGHTS DURING THE TIME (name incident) WAS GOING ON; THAT IS, WHILE IT WAS HAPPENING						
DID YOU FEEL ANY OF THESE: NOT AT ALL, SLIGHTLY, SOMEWHAT, VERY MUCH, AN EXTREME AMOUNT ?						
DID YOU FEEL...	NOT AT ALL	SLIGHTLY	SOMEWHAT	VERY MUCH	AN EXTREME AMOUNT	
THAT YOU, OR A SIGNIFICANT OTHER, WOULD BE SERIOUSLY PHYSICALLY INJURED OR KILLED ?	0	1	2	3	4	
PTSD Criterion A1 total →						/4
FEARFUL ? SCARED ?	0	1	2	3	4	
HELPLESS ?	0	1	2	3	4	
PTSD Criterion A2 total →						/8
DID YOU EXPERIENCE...	NOT AT ALL	SLIGHTLY	SOMEWHAT	VERY MUCH	AN EXTREME AMOUNT	
SHORTNESS OF BREATH ?	0	1	2	3	4	
TREMBLING, SHAKING, OR BUCKLING KNEES ?	0	1	2	3	4	
HEART POUNDING OR RACING ?	0	1	2	3	4	
SWEATY PALMS OR OTHER SWEATING ?	0	1	2	3	4	
STRS Acute Autonomic Activation Indicators total →						/16
Date	DOB		ID			
Interval since incident		<h2 style="margin: 0;">STRS Total →</h2>				/28

Figure 1

Table 2: Frequency, mean years since incident, rating means and rating mean ranks for 14 original and 7 STRS items for each incident

Stressful Incident	N	Yrs Since Incident	Total 14 Orig. Items		Total 7 STRS Items	
			Mean (SD)	Mean (SD)	Rnk* Mean (SD)	Rnk*
Caregiver, close friend, relative died of natural cause	18	5.8 (3.7)	18.6 (10.6)	10	15.0 (7.8)	9
Serious motor vehicle accident	16	5.2 (3.2)	22.3 (12.6)	6	17.2 (7.0)	5
Caregiver, close friend, relative very ill or injured	16	4.6 (3.4)	16.1 (8.0)	12	14.0 (5.4)	11
Other situation, feared death or serious injury	14	5.7 (4.0)	26.4 (11.4)	3	19.2 (5.2)	2
Any other extraordinarily stressful situation	13	6.1 (4.2)	20.8 (8.4)	7	16.8 (5.2)	6
Natural disaster	11	9.9 (3.9)	18.1 (12.2)	11	15.6 (9.3)	8
Attacked with weapon, intent to kill/seriously injured	10	7.5 (2.0)	32.1 (11.5)	1	22.7 (5.7)	1
Serious surgery	10	6.2 (4.5)	31.0 (11.2)	2	17.6 (5.1)	4
Other situation, saw someone seriously injured or killed	6	4.2 (3.5)	23.3 (10.6)	5	17.7 (5.0)	3
Serious problems or broken up with significant other	6	3.8 (2.6)	23.8 (4.8)	4	15.7 (1.4)	7
Bullying, hazing in school	6	8.2 (3.2)	18.8 (8.6)	9	14.7 (5.5)	10
Parents had serious Problems or conflicts	6	9.8 (4.4)	13.7 (6.4)	13	11.8 (5.3)	12
Other actual serious injury	5	7.0 (5.3)	20.8 (5.3)	8	13.8 (4.1)	13
Attacked without weapon, intent to kill/seriously injure	4	8.0 (4.2)	31.0 (16.3)		19.3 (6.8)	
Serious accident at work/elsewhere	4	8.4 (4.0)	30.0 (13.2)		18.6 (5.6)	
Serious injury	4	7.5 (3.1)	22.3 (7.1)		18.3 (6.6)	
Broken bone with cast	4	8.8 (4.4)	13.3 (1.9)		12.3 (0.5)	
Bullying, hazing outside school	3	5.7 (5.5)	16.0 (5.0)		14.7 (4.2)	
Close friend or family member killed by drunk driver	1	1.0	43.0		28.0	
Sudden separation from parent/caregiver	1	3.0	28.0		20.0	
< 21, sex contact with physical force/threat of force	1	4.0	35.0		19.0	
Caregiver, close friend, relative deployed war zone	1	11.0	18.0		18.0	
Panic when blood drawn	1	10.0	26.0		18.0	
Divorce/separation spouse/lover	1	4.0	12.0		10.0	

*Rnk = Rank of means in descending order for incidents rated by 5 or more participants

years old at the time it occurred. This resulted in 1,110 incidents rated by 236 participants. In order to ensure the independence of ratings, only one incident per participant was included in the analysis. We selected this incident using the highest total score on the original 14 items as the inclusion criteria, resulting in a dataset with 236 incident ratings.

To match the DSM-IV-TR PTSD definition of criterion A1 and to further ensure that ratings were based on incidents most likely to provoke acute distress, we excluded observations in which the criterion A1 item ("Thought you would be seriously injured or killed" during the incident) was rated "Not at all", leaving a final dataset of 162 incident ratings from 162 participants.

Data were analyzed using SAS® v 8.2 software (SAS Institute, Cary, NC). A factor analysis using maximum likelihood estimation was performed with the Factor procedure using both orthogonal and oblique rotations to accommodate presumed correlation between factors. Prior communality estimates were set to the squared multiple correlation of each item with the remaining items. Results from the factor analysis were checked for consist-

ency by performing a cluster analysis using the Varclus procedure. Frequency of endorsement was analyzed using the Freq procedure.

Results

Of the 162 participants retained in the final dataset, 60% (n = 97) were male. The mean ± SD age at time of interview was 20.6 ± 2.7 years for males and 21.1 ± 2.6 years for females. Participants were ethnically diverse (Caucasian = 26%, Japanese = 24%, Filipino = 14%, Hawaiian = 12%, other = 24%) and largely middle class (SES: Low = 7%, Low-middle = 17%, Middle = 50%, High-middle = 22%, High = 4%).

The mean ± SD age at the time of the rated incident was 14.4 ± 3.8 years. The mean ± SD number of years since the incident was 6.4 ± 3.9 years, and the mean ± SD total score for all 14 original items was 22.0 ± 11.0. The types of distressing incidents and their mean total scores on the original 14 items, and on the seven items on the STRS, and the ranks of mean total scores are listed in Table 2.

The endorsement rates of the sample are presented in Table 1. Items 5, 9, 10, 11, 12, 13, and 14 were endorsed

Table 3: Factor loadings and final communality estimates for each item

Latent Variable	STRS Item	Factor 1	Factor 2	Final Communality Estimate
Acute Autonomic Activation Indicators	trembling, shaking, buckling knees	0.86	0.45	0.41
	sweaty palms or other sweating	0.72	0.37	0.56
	shortness of breath	0.76	0.47	0.52
	tachycardia, heart pounding, or racing	0.65	0.58	0.58
PTSD Criterion A Indicators	you or other injured or killed	0.38	0.75	0.49
	helpless	0.43	0.72	0.74
	fearful or scared	0.38	0.64	0.52

(rated greater than "Not at all") by fewer than 60% of participants. The low endorsement rate of these items suggests that the phenomena they tapped were not remembered or not experienced by a large proportion of persons exposed to acute stress. These items were discarded and data from them were dropped from all subsequent analyses.

Conducting and interpreting the results of a factor analysis of a scale involves two steps: a) determining the number of factors that best summarize the covariance patterns among all the items; and b) judging how well individual items that share similar factor loading patterns map onto theoretically coherent constructs or latent variables, i.e. how interpretable the factors are. Theoretical considerations led us to expect that two latent variables would best represent the data: a) non-volitional (brain-stem) autonomic activation, and b) DSM-IV-TR PTSD criterion A. We tested this assumption by analyzing one-factor, two-factor, and three-factor models.

Two factors possessed eigenvalues greater than one. The sharp elbow in the scree-plot after the second factor and the attainment of minimum values of Akaike's information criterion (AIC) and Schwarz's Bayesian criterion (SBC), confirmed the appropriateness of the two-factor model over the one- and three-factor models (AIC = 47.39, -5.88, -4.44 and SBC = 4.17, -30.58, -13.70 for the one-, two-, and three-factor models, respectively).

The two factors were moderately correlated with one another ($r = 0.54$). The correlation between factors does not allow for accurate estimates of variance accounted for uniquely by each factor; therefore, these estimates are not presented. The two factors together accounted for 68% of the common variance among the items. The single-factor model explained only 50% of the common variance suggesting that a higher order factor was not the most parsimonious representation of the data.

Table 3 contains the factor loadings for the seven items on the two factors. The four items reflecting autonomic activation

loaded onto the first factor (0.86, 0.72, 0.76, and 0.65, after rotation). The three items focusing on criteria A1 and A2, all loaded heavily onto the second factor (0.75, 0.72, and 0.64, after rotation). These seven items constitute the STRS. The variance in each item accounted for by the two factors together (the final communality estimates, Table 3) ranged from 41% to 74%.

Discussion

The four autonomic activation items included in the STRS (Shortness of Breath, Tremulousness, Racing Heart, and Sweating) checklist cover the signs of acute autonomic activation most clearly recalled or experienced by participants. Research suggests that these signs are likely to be valuable for both prognosis and diagnosis in a variety of trauma-exposed populations. They are not captured by the current criterion A2 for PTSD, which is increasingly seen as too broad.

The two factors in the STRS, 1) criterion A and 2) acute autonomic activation indicators, are distinct yet moderately correlated with one another. This is consistent with a theoretical model depicting two related but distinct dimensions of the human acute response to extreme emotional stress, one primarily cortical and one primarily non-cortical (acute autonomic activation).

The distinctness of the factors suggests that the four indicators of acute autonomic activation tapped by the STRS constitute a significant independent dimension of the acute response to stress. This dimension has the potential to provide incremental validity over and above the PTSD criterion A2 items of the DSM-IV-TR. The easily interpretable factor structure of the STRS confirms the adequacy of the two theoretical latent variables: 1) PTSD diagnostic criterion A, and 2) peritraumatic acute autonomic activation.

Several sample characteristics suggest the need for caution in generalizing our findings either to a more trauma-exposed population or to the general population. Our sample was selected according to the needs of a parent

investigation of dental biomarkers of premorbid autonomic activation [20,21,32,33]. Because of the necessity of obtaining dental tissue from all participants, participants were not randomly selected from the general population. Many participants were students and most were middle class. The intensity of the peritraumatic experiences in our sample may have been less than in a population recently exposed to an extreme stressor, such as a natural disaster, terrorism against civilians, or combat. The length of time since the incident (up to 14 years) rated by each participant may have diminished the participant's recall of details of their experience. Such recall biases, however, will impact any self-report measure of past trauma. Furthermore, such recall biases will impact the self-report of current PTSD criterion A2.

It would be worthwhile to examine the endorsement rates of all the original 14 items in a sample recently exposed to an extreme stressor. This would permit analysis of the time effect on recall and on ratings of different autonomic activation signs. Our findings reflect the factor structure of these items and do not speak to either the resulting scale's reliability or its predictive power. Research examining these important psychometric issues is ongoing.

Our finding of a very low endorsement rate (3.1%) for the bladder/bowel control (parasympathetic activation) item confirms the similar finding in men by Brunet et al. [27]. Since the stigma of reporting these two physical signs of extreme fear is probably greater among men, it is noteworthy that our study extends Brunet's finding to young women.

The remarkable brevity (two minutes or less) of the STRS checklist is unique and particularly desirable in clinical settings for two reasons: a) the minimal burden it will impose on individuals in the acute aftermath of exposure to extreme stress, and b) the ease of administration and scoring. In clinical settings it can be informally administered from memory and scored in standard progress notes. In research settings, the brevity of the STRS allows for repeated administration. Future research is warranted to explore whatever the four acute autonomic activation items of the STRS can be useful as the basis for a possible PTSD criterion A3 in the DSM-V.

Additionally, because of their hardwired involuntary nature, the acute autonomic activation indicators may be less stigmatizing than cognitive/cortical A2 items, such as "helplessness" and "horror." This focus on the hardwired involuntary alarm response may make the STRS less vulnerable to stigma-related bias among veterans, military personnel, police officers, firefighters, and males in general, in whom stigma may be a self-imposed obstacle to treatment. The STRS may also be less vulnerable to stigma-

related bias in Japanese, Chinese, and Pacific-Islander cultures. Stigma has been shown to be an obstacle both to research and clinical care in some of the above populations [28,29,34].

Conclusion

The STRS has a robust and clearly interpretable factor structure. The four acute autonomic activation signs it taps (shortness of breath, tremulousness, racing heart, and sweating) are distinct from current PTSD criterion A2 and have the potential to usefully supplement criterion A2 in the prediction of PTSD. The STRS items may be less stigmatizing than criterion A2 items and may therefore be of particular utility in a variety of populations in which stigma is an obstacle to treatment and research. The brevity of the STRS checklist (two minutes or less) is especially noteworthy. In research settings the STRS checklist may be easily added to current PTSD assessment batteries.

Competing interests

None declared.

Authors' contributions

HSB is the principal investigator who conceived, planned and organized the study. AEW conducted the analyses and drafted the paper. SNH provided research design expertise. ESK provided clinical supervision. TCR and JMM collected and inputted the data. All authors made substantial contributions to the text.

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